the least difference was 0.0°, both in February and April 1932.

The annual mean temperatures at the two locations appear to be slightly less divergent in recent years than in the years at the beginning of the records. For the first 4 years the average difference was 1.2°, whereas for the last 4 years it was 0.8°. That this change has been brought about almost wholly by more nearly equal minimum temperatures is revealed by the fact that the average annual mean daily maximum temperatures for the first 4 years of record were 0.5° lower at the university, and for the last 4 years 0.4° lower, whereas the mean daily minimum temperatures were 1.8° lower at the university for the first 4 years, but only 1.3° lower for the last 4. Whether this discrepancy of 0.5° is due to the use of different minimum thermometers having unlike corrections that were not applied, to the erection of the social sciences building, or to something else, is uncertain. Possibly the differences are of a wholly natural character.

Finally, the most interesting result in this comparison is the fact that these two stations, only 7 miles apart and with about the same influence exercised on each by a large body of water, show divergences in the differences between their monthly mean temperatures of 1° or more in 9 of the 12 months. This divergence is greatest, 2°, in September. Even the annual mean temperature itself shows a divergence of 0.6°. And, of course, even larger divergences appear both for the monthly mean daily maximum and mean daily minimum temperatures, ranging for the mean maximum temperatures from 1° in December to 1.8° in February, and for the mean minimum temperatures from 1.3° in June to 3.1° in September. These facts show what uncertainty may exist when interpolating for missing records. If these comparatively large divergences exist for stations as close together as 7 miles it is reasonable to assume that as large or even larger divergences exist for stations farther apart, as, for example, in the case of two cooperative stations 25 or 30 miles apart.

METEOROLOGICAL CONDITIONS AND WHEAT YIELDS IN FORD COUNTY, KANS.

By CLARENCE E. KOEPPE

[Southwest Missouri State Teachers College, Springfield, Mo., Apr. 24, 1934]

There have been numerous studies made of the relation of weather conditions to crop yields—many quantitative but most of them only qualitative. Several quantitative studies of *wheat* yields and weather conditions have been made during the past 20 years, notably by J. W. Smith, particularly in Ohio, and by Hessling in the Argentine. There is, however, marked disagreement in almost all of the studies, which have been made, due probably to at least two causes: (1) The difference in geographic location and consequently in physical conditions. For example, rainfall seems to be less critical in Ohio than in Kansas, because in Kanass available moisture frequently is insufficient, while in Ohio wheat rarely suffers from lack of moisture; (2) the interrelations of the meteorological elements are so complex that it is difficult to establish whether, for example, a poor yield of wheat is due to too little rain in September, too high temperatures in October, lack of snowfall in January, too much rain in April, too strong winds in May, or whatnot else. There are discussed here only a few of the more apparent, though perhaps less real, relationships between yields of wheat and the elements of temperature (including maximum and minimum), rainfall, snowfall, rainy days, and wind velocities. No account has been taken of frost, hail, ice storms, sunshine, and cloudiness; and only slight consideration has been given to frequencies and sequences of weather elements.

The original plan was to select long-period data for at least three counties in Kansas, and to calculate partial and multiple correlations. Obviously the task was too great. Hence, and unfortunately so, this paper deals only with a 10-year period, 1921–30, for yields of wheat in Ford County, Kans., and with the meteorological data for the corresponding 10-year period at the county seat, Dodge City, which are assumed to be representative of those of the area in question. The meteorological year was taken from August 1 to July 31, rather arbitrarily to be sure, yet not entirely without justification since some wheat is harvested in July. Probably rainfall in July, however, has as much to do with the wheat crop the following year as it does with that of the same year.

The methods employed in arriving at the conclusions which follow were the usual ones, viz, the plotting of the data to note any marked correlations and in order to determine whether the relationship between the wheat yields and each of the several weather elements was linear or otherwise; the calculation of mainly simple correlation coefficients, with some partial and multiple correlations; the calculation of the probable error; and so on. In some instances there was very definite linear relationship; in others the points were so scattered that even a parabola failed to fit them. The attempt here, however, is not to discuss methods of correlation, but merely to point out a few of the more significant and striking relationships which seem to exist between the meteorological conditions by months and the wheat yields the following season.

There is a general impression that rainfall is the most critical factor in the production of winter wheat in central and western Kansas. Results of this study failed to show any such outstanding connections. Probably the most significant relationship was the fact that fairly moist Augusts, Septembers, Octobers, Januarys, and Februarys, and distinctly dry Aprils were followed by good yields of wheat the following Junes or Julys. The exceptionally low yields of 1925 and 1927 were preceded by April rainfall above normal, while the exceptionally high yields of 1926 and 1928 were preceded by April rainfall below normal. The low yield of 1923, which was 6 bushels to the acre when only one-fourth of the normal acreage was harvested, was preceded by a dry April, but by a May in which the rainfall was three times the normal amount. Conparison of wheat yields with the longest rainless intervals in the March-to-May period gave a negative correlation of 0.32, which figure has little if any significance. There was even less correlation when the period was extended from February to June, inclusive. A large number of rainy days in August and October seemed to be favorable for large yields the following year.

The total yearly snowfall showed a correlation of +0.50. April snowfall showed a relatively high correlation of +0.71, although this high figure may be due to too scattered data, many Aprils having no snow; that is, the yields of wheat may have been large in spite of April snowfall rather than because of it. Snow in February seemed to be desirable, more so than in March; but snowfall in November and December correlated negatively, although the coefficients −0.15 and −0.24 were too small to be considered as significant.

The most striking point in connection with *temperature* was the fact that both maximum and minimum temperatures from November to March, inclusive, had practically no influence on wheat yields the following season. But temperatures below normal in both October and April were followed by large yields the following summer. The remakably high yield of 1926, which was 21 bushels to the acre, followed an October in which 24 days had both maxima and minima below their normals for the month. On the other hand, a correspondingly high yield in 1928 followed an October which experienced maximum temperatures slightly above normal, although the minima were practically normal. Minimum temperatures below normal in June seemed to favor higher yields, the correlation being −0.60. Correlation of the number of days in a month in which temperatures were above or below certain temperatures which seemed to be critical, revealed practically no relationship except in October, April, and possibly November. Large yields seemed to be favored by a large number of frost days in both October and April; but temperatures below 20° in November seemed to be slightly unfavorable. An interesting point was the fact that the correlation between wheat yields and the number of 0° days in January was exactly zero. The only other relationship revealed was the fact that temperatures in excess of 85° in May were slightly unfavorable, the correlation being −0.35.

Thornthwaite's formula,[1] $\frac{P}{E}=11.5\left[\frac{P}{T-10}\right]\frac{10}{9}$, in which $\frac{P}{E}$ is the precipitation-evaporation ratio, P the precipitation in inches, and T the temperature in degrees Fahrenheit, was used to compute ratios for each month for the entire period, and these ratios were correlated with wheat yields. This was done in order to show the relation between wheat yields and two variables, temperature and precipitation. The results revealed nothing more than did either temperature or pecipitation alone. That is, high precipitation-evaporation ratios in April were followed by low wheat yields, and this was also true to a slight degree for August and December; while large precipitation-evaporation ratios in September favored high wheat yields the next summer.

The most conclusive of all correlations were those with wind velocities. The only significantly positive correlation was in December with a coefficient of 0.44, indicating the desirability of strong winds in that month. This seems absurd, and doubtless the yields of wheat in summer are good in spite of high winds in December. Wind velocities in October, February, April, and July revealed nothing worth considering. But strong winds in September and March clearly affected wheat yields, the correlations being −0.77 and −0.74, respectively. This was only slightly less true in May and June. Strong winds in November and January also seemed to indicate an adverse effect on wheat.

The general conclusion is that a cool October with rather dry air, but frequent small showers, and a cool April with a small amount of precipitation, few rainy days, but relatively moist air and not too much wind in early fall, late winter and spring, are favorable conditions for good yields of wheat the following season.

[1] C. W. Thornthwaite: The Climates of North America According to a New Classification. *Geographical Review*, vol. 21, 1931, p. 639.

CENTRAL OFFICE OF UNITED STATES WEATHER BUREAU STRUCK BY LIGHTNING

By ALBERT K. SHOWALTER

[Weather Bureau, Washington, April 1934]

At about 3:50 p.m., April 24, 1934, I was using the extreme northwest corner of the main building of the Weather Bureau, Washington, D.C., as a sighting point, from a west window of the annex, to check the movements of the clouds in a vigorous thunderstorm that was approaching from the west-northwest. While looking at this corner it suddenly became a terminus for a lightning discharge which occurred between the building and a northwest cloud. The discharge had the appearance of an ordinary streak of lightning which flashes from clouds to earth. However, at the same instant there appeared adjacent to the corner struck an exceptionally brilliant blaze of reddish light, which was somewhat round but not a perfect sphere, and pieces of brick and stone were thrown in all directions, except upward.

The thunder was not very loud. I had been quite close to lightning strokes before and each time I heard a deafening crash which left a ringing sensation in my ears for some minutes afterward. On this occasion however, I heard only a small crack at almost the instant of the flash.

I have discussed this lightning flash with several other persons who were in the room with me, or in adjoining rooms at the time of its occurrence. Their impressions were in general in harmony with my own. Mr. J. H. Gallenne observed the streak of lightning in the northwest but did not see it strike. Mrs. I. J. Brinks saw the flare adjacent to the corner struck and said it had a very reddish tint and although it was somewhat round it did not have the exact appearance of a ball. Mrs. R. R. Kass saw it also and said that to her it seemed to be a distinct ball.

NOTE.—No one was hurt and the material damage was inconsequential.—EDITOR.

THE "SINKING" OF LAKE AND RIVER ICE

By W. J. HUMPHREYS

In the spring, as Tennyson puts it, some of us are prone to obsessions. One of these obsessions is that of the boatman, fisherman, and lots of others, who swear that at this season surface ice becomes rotten, or honeycombed, and sinks. They know it sinks because in the evening the lake, for instance, may be covered with a sheet of old ice from end to end and shore to shore, and by the next morning no trace of the ice left, save little patches here and there along the water's edge. "Of course it sank", they say, "how else could it have disappeared so rapidly?" And river men tell us not to worry about the ice coming downstream from a broken jam above, for before getting very far it will go to the bottom like a rock. Evidently it can be sunk, and sometimes is, just